Polymer Processing Lab 1
Injection Molding of Thermoplastic Parts

Objectives: To become familiar with a small-scale injection molding operation.

Background: Chapter 14 pp. 584-610 deals with injection molding. It is also briefly mentioned on pp. 11 to 14 in chapter 1. We will use a pilot plant version of the Farrel Injection molding machine shown in figure 1.14 pp. 14. The process has been discussed in class in terms of the steps in an injection molding process figure 1.13 pp.13, the processing window, figure 14.3 pp. 591, and the terminology associated with the process, Introduction class notes '98. We have also discussed the molecular weight dependence of viscosity for polymer melts which follows a 3.4 power-law. Polymer resins (usually pure polymer or partially compounded polymer pellets formed from a short extruder) are graded according to their melt index or ***melt flow index***. This is measured on a relative scale which varies with the resin being considered. A capillary rheometer is used to grade the resin. The melt is forced through a capillary with a standard pressure and the mass of polymer is measured after a standard amount of time. High melt index means low viscosity.

Several melt index resins of polycarbonate (at least 3) will be run through the injection molder at several injection pressures and at several temperatures. A simple rectangular die will be used. The features of the injection process which you should observe are:

1) Short shot, incomplete filling of the mold due to insufficient pressure, of too low of a melt temperature. Gogos has used short shot situations to test prediction of melt flow in an injection molding process on pp. 592 and 594. For the simple rectangular mold design used here short shot analysis should follow the early stages of #1 in figure 14.5.

2) Flashing, melt is too hot or too much pressure has been applied.

3) Orientation as an indication of melt flow history in sample. Use two crossed polarizers on either side of the final parts. The orientation should increase with lower temperature and higher injection rates. You should try to make slices through the samples to observe the lateral orientation as in figure 14.4 on pp. 591.

4) Filling time versus temperature and pressure.

Questions:

1) Construct a crude processing window for the different grades of PC used in this lab similar to Figure 14.3 on pp. 591.

2) Make crude plots of fill time versus temperature and pressure. Discuss optimization of this process.

3) Use the equations on page 587 to calculate the position of the melt front Z(t) as a function of time for several of the injection situations you investigate in this lab. Is there evidence in the crossed polar view of the samples or in the short shot runs that these calculations are correct?

4) Do short shot runs support figure 14.4? Is there any evidence for the fountain effect?

5) Problem 14.7 in Tadmor. Discuss these results with respect to the experiment conducted here.

6) What constitutive equation is appropriate for the various parts of an injection molding operation performed in this lab? Consider only the gate and mold components i.e. only the injection process.

Your lab report should include a description of the injection molder including model number and brand, a sketch of the mold and mold dimensions, description of the resins including source and melt index, copies of your lab notebook describing the samples which were made and the processing conditions, hand sketches of orientation etc. Please follow the rules for lab reports and rules for lab notebooks which are in separate handouts.